	A	B	C	D	E	F	G	H	I
1	**COOP**	**Approximate Number of Customers**	**Approximate KWH Sold in 2005**	**MW Needed Per 241 Customers**	**Number of 1 MW Turbines To serve 25%**	**Installed MW**	**Number of 2.1MW Turbines Needed to provide 100% usage**	**Number of 2.1 MW Turbines To serve 25%**	**Number of 100 kW Turbines To serve 25%**
2	Beartooth Electrical Coop	4,089	57,810,829	17	3		8	2	42
3	Big Flat Electric	1,015	27,163,689	4	1		2	0	11
4	Big Horn County Electric	3,758	60,714,390	16	3		7	1	39
5	Fall River Electric	1,759	42,440,018	7	1		3	1	18
6	Fergus Electric Coop	5,813	109,005,976	24	5		11	2	60
7	Flathead Electric Coop	45,800	1,304,519,208	190	38		90	18	475
8	Glacier Electric Coop	4,900	156,000,000	20	5		10	2	51
9	Goldenwest Electric Coop	633	18,672,825	3	1		1	0	7
10	Hill County Electric Coop	2,200	130,000,000	9	2		4	1	23
11	Lincoln Electric Coop	4,700	14,963,680	20	5		9	2	49
12	Lower Yellowstone REA	4,000	87,000,000	17	4		8	2	41
13	Marias River Electric	3,687	81,175,102	15	4		7	2	38
14	McCone Electric Coop	2,441	56,600,000	10	3		5	1	25
15	Mid-Yellowstone Electric	1,896	22,994,952	8	2		4	1	20
16	Missoula Electric Coop	10,469	191,363,128	43	11		21	5	109
17	Northern Electric	1,263	30,734,717	5	1		2	1	13
18	Northern Lights Inc	3,454	72,800,000	14	4		7	2	36
19	Park Electric	3,223	135,915,384	13	3		6	2	33
20	Ravalli Electric Coop	7,520	127,986,065	31	8		15	4	78
21	Sheridan Electric Coop	1,816	92,259,105	8	2		4	1	19
22	Southeast Electric	945	48,370,000	4	1		2	0	10
23	Sun River Electric	4,170		17	4		8	2	43
24	Tongue River Electric	4,855	81,692,060	20	5		10	2	50
25	Valley Electric Coop	1,230	21,565,728	5	1		2	1	13
26	Vigilante Electric	4,677	126,568,862	19	5		9	2	49
27	Yellowstone Valley Electric	15,300	15,720,947	63	16		30	8	159
28	**MDU**	24,447	294,533,000	101	25		48	12	254
29	**Northwestern Energy**	316,000	2,466,000,000	1,311	328	130	624	156	3,278
30	Montana Electrical Coop**	153,931	3,800,054,589	639	160		304	76	1,597
31	**TOTAL**	494,378	6,560,587,589	2,051	513	130	977	244	5,128

Prepared in Fall of 2006 by Ryan Cobb and Russ Doty

Conclusion: Only need 3 more wind farms the size of Judith Gap to be at 25% wind in the grid

Response to Paper Entitled
"Agreed upon Feasibility of Integrating Up to 20% Wind Energy Into the Nation's Electric Systems" by Russ Doty

Critique by NorthWestern Energy, January 29, 2007

The author has made extensive use of a report from the Utility Wind Integration Group (UWIG). While the UWIG finding in its May 2006 paper indicates that there are no technical barriers to wind penetration up to 20% of peak demand, the laws already on the books in Montana call for even greater wind penetration. The Montana law requires that wind energy contribute 15% of the total system energy. Assuming a system load factor of 70% (typical NWE load factor) and a wind capacity factor of 38% (Judith Gap 2006 capacity factor), that translates to a wind capacity penetration of nearly 28% of system peak load. These laws were passed without due consideration to the technical constraints affecting transmission lines. Even the UWIG study noted in a footnote to the statement quoted by Mr. Doty that this conclusion would need to be reviewed upon the availability of actual operating results. NorthWestern Energy's Manager of Control Center Operations recently made a presentation at a UWIG forum sharing our experience with actual wind generation. Many of the participants appreciated the fact that he shared actual operating experience and not just theoretical study results. Already many on the UWIG are questioning the statement made in their May 2006 paper.

NorthWestern Energy challenges the UWIG finding that there are not technical barriers to 20% wind penetration. In fact, Mr. Doty alludes to a quote from the UWIG report that "the actual impact of adding wind generation in different balancing areas can vary depending on local factors. For instance, managing large wind output variations and the steep ramping of generation equipment over a short period of time could be challenging for smaller balancing areas, depending on the specific situation." A key message is that the effects of wind integration are a function of the size and diversity of the system being affected. The Montana grid may be geographically large, but it is small and undiversified by all technical measurements of grid size.

To some considerable degree, Mr. Doty has greatly over-simplified reality with respect to energy imbalance and reserves. He refers in several places to those products as though they are one and the same. In fact reserves are broken down into regulating reserves and contingency reserves, and contingency reserves are further broken down into spinning (on line and responsive to frequency deviations) and non-spinning (available within 10 minutes) reserves. Energy imbalance is yet another product. Each of these separate products serve different needs on the grid, and each reflect different market liquidity. Mr. Doty inaccurately describes contingency reserves as being available to serve load during different periods of variability. Contingency reserves – spinning and non-spinning – are used exclusively to respond to forced outages beyond the control of the operator. Loss of fuel supply – including wind variability – is not a forced outage that permits the operator to call on contingency reserves.

Regulating reserves must be available on a moment-by-moment basis and respond to automatic generation control signals in both directions – increasing and decreasing generation as needed to balance supply with demand. This is the product most impacted by variable generation and is a product very difficult and expensive to procure. NorthWestern also notes that except for hydroelectric resources, the reserves Mr. Doty refers to as being available to ramp up quickly and which might be suitable for regulating reserves simply haven't been developed in Montana. And the hydro resources have limitations (primarily river flows for fisheries) that prevent them from being used for ramping and in particular for regulation.

While there is extensive reference to wind integration in Europe, it is largely irrelevant to the situation in Montana. The grid standards are significantly different in Europe than they are in the United States. The standards in Europe accept frequency deviations as much as 2% of nominal while in the United States the maximum deviation acceptable before load shedding begins is 8/10 of 1%. To reduce our standards to those acceptable in Europe would require a national consensus that is highly unlikely anytime soon. Grid standards are not set by state legislators but rather by the North American Electric Reliability Council (NERC) that operates at the behest of the Federal Energy Regulatory Commission (FERC) pursuant to the Energy Policy Act of 2005. Because the western grid is a contiguous machine operating across western North America, the standards cannot be different in one state than they are in another.

The book Wind Power in Power Systems by Thomas Ackermann, a European professor and researcher with the Royal Institute of Technology in Stockholm, Sweden, is a veritable Bible for the wind industry and is frequently quoted out of context to describe the extensive integration of wind in Europe. Upon reading the entirety of the text, however, it is clear that in Europe that there are substantially more controls on wind generation than currently exist in the United States. For example, in Ireland when frequency exceeds nominal, wind generation must shut down or vary its pitch to reduce production. Conversely, wind turbines are required to adjust their pitch so that they produce less than full wind capability so that in events when frequency is low, they can immediately respond by increasing generation.

References by wind advocates to Denmark, are particularly misleading since the Danish transmission grid operates in a common electricity market much like a regional transmission operator (RTO) with 3 neighboring countries (Nord Pool consisting also of Norway, Sweden and Finland) all sharing regulating reserves on an actual cost basis. NorthWestern and several other utilities worked on such a proposal for the Pacific Northwest for over ten years, but it never came together for a host of reasons beyond the scope of this paper. Suffice it to say that an RTO more easily enables the integration of wind resources. Such an operation is not likely anytime soon in the western grid of the United States.

It is critical that policy makers in Montana understand the unique situations that exist in our state and recognize that it can be costly to try to force fit other solutions on to our unique problems. We tried 10 years ago with the legislation popularly known as the deregulation bill with frightful results.